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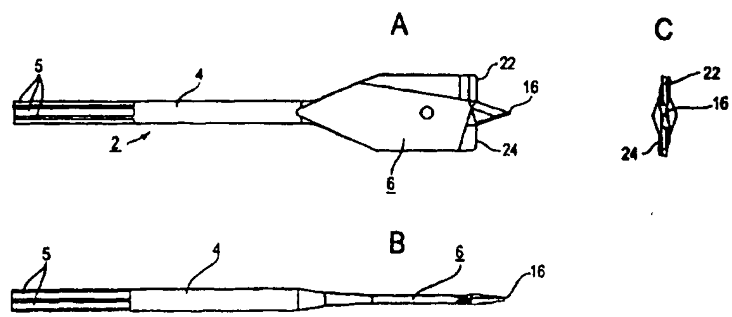
(54) Title: SPADE BIT



(57) Abstract

A spade drill bit design in which the chip flow direction along the cutting edge (22, 24) is always in the same direction is disclosed. As the chip flow direction is governed by the chip velocity vector, the cutting edge (22, 24) is designed so that the chip velocity is always generally perpendicular to a line drawn on the main cutting edge (22, 24) to the center axis of the cutting bit.

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Spade Bit

Field of the Invention

This application is based on Provisional Application No. 60/023,735, having a filing date of 8/8/96. A corresponding United States Application was filed on August 6, 1997 (serial number not yet known).

The present invention relates to a drill bit. More specifically, the present invention relates to a spade type drill bit. More particularly still, the present invention relates to a spade type drill bit in which the chip flow direction all along the cutting edge points in the same direction.

Background of the Invention

In conventional spade type drill bits, such as that depicted in Figs. 2A-C of the present application as well as in U.S. DES. 372,485, the chip flow varies along the cutting edge. Conventional spade bit designs consume excess energy in cutting action in that energy is consumed in tearing apart a chip as it is created. In addition, as chips are broken up into smaller pieces, they become more difficult to clear out of a hole being drilled. Conventional spade designs also tend to create vibrations which reduce the quality of the hole being drilled. In addition, many conventional designs include spurs on the outer edges of the drill bit which result in localized high temperature and high wear rates. See e.g., U.S. Patent No. 4,753,558. The present invention uses a rounded corner design which increases the surface area and reduces the temperature at the edges of the bit resulting in a longer tool life and a reduction in the need for sharpening. Also see U.S. Patent Nos. 5,099,933 and 5,145,018.

Summary of the Invention:

The present invention overcomes many of the deficiencies of the prior art. The present invention features a drill bit design in which chip flow all along the cutting edge always goes in the same direction. This is accomplished in the

illustrated embodiment of the present invention by aligning the chip velocity vectors to be always perpendicular to a line drawn from each point of the main cutting edge to the center axes of the spade bit. By having all of the velocity vectors point in the same direction, the chip flow is also always in the same direction. In addition, the present invention results in a spade bit in which the quality of the hole drill is improved and the ease of hole cleaning is improved. Due to the fact that the chip flow direction is always in the same direction, the chips do not break up into smaller chips during the drilling process. This makes it easier to clear out the hole. In addition, by causing the chips to flow in a single direction, vibrations are reduced which results in a superior quality hole.

In addition, prior art spade bit designs results in drilling operations where the chips remain in the hole which tended to clog up the hole and put additional strain on the drill motor. This results in occasional blockage and even damage to the drill motor. These detriments are also alleviated by the present design.

Third, conventional spade bit designs included spurs on the outer edges of the bit which resulted in high localized temperatures and a high wear rate. Spade bits designed in accordance with the present invention will preferably have a rounded corner on the outer edge which not only increases surface area in order to reduce maximum temperature along the rounded edge, it also results in a bit that advantageously exhibits longer tool life and maintains its cutting edge without sharpening longer relative to conventional designs. Further, by eliminating the spurs used in conventional designs, the present invention eliminates the problem wherein the drill bit would tend to "grab" when exiting the hole.

The present invention and its energy deficiency, is particularly advantageously when drilling a plurality of holes using cordless drills having limited battery life.

Further embodiments of the invention provide a cutting edge having chip breaker elements and a novel self threading point design.

It is therefor an objective of the present invention to provide a drill bit in which the chip flow direction is the same all along the cutting edge.

It is a further object of the present invention to provide an energy efficient drill bit. It is a further object of the invention to provide a drill bit in which wood chips tearing is minimized.

It is a further object of the invention to provide a drill bit design in which chips are more easily cleared out of the hole being drilled.

It is yet a further object of the invention to provide a drill bit design which reduces drill vibrations and results in better quality holes.

It is still a further object of the invention to provide a drill bit design which reduces strain and possible damage to the drill motor resulting from hole blockage.

It is yet a further object of the invention to provide a drill bit having a lower wear rate and which, during drilling, avoids excessively high localized temperatures.

It is yet a further object of the invention to provide a drill bit which exits a piece of wood without grabbing the work piece as it exits the hole.

It is a further object of the invention to provide a self threading drill bit which is largely immune to obstacles, such as nails, which may be encountered in the work piece.

These and other objects of the invention are achieved by providing a spade bit comprising a shank and cutting head. The cutting head includes a point and a pair of cutting edges extending generally radially outward from the point. The cutting edges create velocity vectors of cuttings which are generally parallel to each other along essentially the entire cutting edge. The cutting edges also include chip breakers which provide for chip flow having a uniform speed.

Brief Description of the Drawings

The accompanying drawings, which are incorporated in and form part of the specification illustrate various embodiments of the present invention and together with a description serve to explain the principles of the invention. In the drawings:

Figures 1A, 1B and 1C are respectively a top view and a side and edge projection view of a first embodiment drill bit according to the present invention.

Figures 2A, 2B and 2C are respectively a top view and a side and edge wise view of a conventional drill bit design.

Figure 3A is a front view in partial perspective, of a spade type drill bit according to the present invention.

Figure 3B is a detail of the cutting edge portion of Figure 3A.

Figure 4A is a front view in partial perspective, of a conventional drill bit design; Figure 4B is an enlargement of the cutting edge portion of Figure 4A.

Figure 5 illustrates an edge view of a drill bit according to the present invention illustrating the chip velocity vectors.

Figure 6 illustrates a bit according the present invention cutting into a wood piece.

Figure 7 illustrates a conventional spade bit and chip velocity vectors.

Figure 8 illustrates a conventional spade bit exiting a wooden work piece.

Figure 9 illustrates a conventional spade bit and the hook angle of the spur portions thereof.

Figures 10A, 10B and 10C respectively illustrate a top view and side and edge projections of a second embodiment of a spade bit according to the present invention.

Figure 11 is an enlargement of the edge projection of Figure 10C.

Figure 12 is an enlargement of the edge projection of the head portion of the drill bit potion of Figure 10A.

Figure 13 is a front view in partial perspective of a drill bit in accordance with the second embodiment of the invention.

Figure 14 is a partial perspective view of the head portion of the drill bit of Figure 13.

Figure 15 is a front partial perspective view of a spade type drill bit featuring four chip breakers, two located on each side of the main cutting edge.

Figure 16A, 16B and 16C are respectfully top view and side and edge projection of third embodiment of the invention having a threaded point.

Figure 17 is an enlargement of the cutting edge potion of the drill bit of Figure 16A.

Figure 18A is a front up standing view and partial perspective of a drill bit in accordance with a third embodiment.

Figure 18B is a detail of the threaded point of the spade type drill bit of Figure 18A.

Figure 19 is another detail and partial perspective of the threaded point of the spade type drill bit according to the third embodiment of the invention.

Figure 20 is a depiction of a threaded spade type drill bit having a conventional thread design.

Detail Description of the Invention

Reference will now be made in detail to various presently preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. In the various figures some of the structures are referenced with similar reference numerals.

As best seen in Figures 1A, 1B and 1C, a bit having a cutting head 6 is provided. The bit includes an elongated shaft 4. The end of the shaft which is opposite the cutting head 6 is preferably provided with hexagonal flats in order to permit it to received in a drill chuck. As best seen in Figure 5, the present drill bit always directs the flow of chips produced during drilling all along the cutting edge in

the same direction. In Figure 5 the velocity vectors **10** are depicted in the illustrated embodiment, the angle α of the velocity vectors **10** is illustrated at an angle of approximately 5.7° which is typical for a 1 inch spade blade. It will be appreciated by the artisan however that the velocity vector angle will vary depending on the thickness of the spade drill and its diameter. In contrast, Figure 7 illustrates typical chip velocity vectors **10'** which would result from a conventional drill design. The velocity vectors **10'** are not parallel to each other and the chip flow along the cutting edge **24'** varies from point to point along that edge. In the illustrated example, the angle of the chip velocity vectors with respect to the center line **12** of the drill bit varies between about 24.5° along the main cutting edge **25** i.e. the edge closest to the point **16**, to about 9° at the outer most point of the main cutting edge **27'**. In Figure 7, the angle of the chip velocity vector with respect to the center line of the drill bit at the point on the main cutting edge closest to the point **16** is designated as β. The angle of the chip velocity vector with respect to the center line **12** at the outer most point of the main cutting edge is designated as γ.

Applicant has found that aligning the velocity vectors results in a more efficient cutting action in that less energy is consumed. In the conventional design of Figure 5, energy is wasted because chips are torn apart as created due to the fact that the chip flow direction is different all along the cutting edge.

Applicant has also found that when cutting chips using a drill bit having chip velocity vectors **10** such as shown in Figure 5, the chips do not break up into smaller chips as they are created which makes it easier to clear the chips out of the hole being created. This tends to reduce vibration and leads to a better quality hole. In addition, Applicant has found that when using a drill bit made in accordance with Figures 1, 3 and 5, that chips easily come out of the hole thereby minimizing the problem of conventional bits where chips tend to clog up the hole and place additional strain on

the motor and in severe cases even blocking the movement of the drill bit and damaging the drill motor.

As best seen in Figures 4 and 4B, conventional drill bit designs include edge spurs **26** and **28** on the outer edges of the bit. The spurs frequently experience high localized temperatures and exhibit high wear out rates. In contradistinction, as best seen in Figures 3A, 3B and 5, the drill bit made according to the present invention preferably has rounded corners **20** and **21** which increases the surface area and reduces the maximum temperature as compared to drill bits equipped with edge spurs. This results in a tool having a longer life and a bit that retains the sharpness of its edge better relative to the conventional design.

Figures 8 and 9 illustrate additional disadvantage of drill bits equipped with conventional edge spurs. As the user of the drill bit prepares to exit the hole, the spurs **26** and **28** of conventional spade bits tend to grab the work piece **30**. Once the outer most parts of the spurs have exited the material **30**, the spurs cause the drill bit to pull itself aggressively back into the material. This is due to the hook angle δ on the spurs of the spade bit as illustrated in Figure 9. In a typical conventional drill bit, the angle δ is about 15°.

When the drill bit starts getting pulled into the material by the spurs, the user will frequently experience a jerk which is typically referred to as grabbing. Grabbing may result in a wood blowout and splintering on the backside because the last portion of the uncut material **31** is pushed out rather than cut.

In comparison, when using a bit equipped with rounded cutting edges **20** and **21** as best seen in Figure 6, both the main cutting edges **22** and **24** basically exit the material at the same time which leads to a smooth cut, less wood blowout and less splintering.

As will now be appreciated by the artisan, a bit made in accordance with the above invention will retain its sharpness longer than a conventional drill, exhibit superior chip

clearing qualities, produces a better quality hole and is more energy efficient. The latter advantage is particularly important when the user is drilling many holes and relying on a single battery pack in a cordless drill application.

A second embodiment of a drill in accordance with the present invention is illustrated in Figures 10-15. In the second embodiment of the design, chip breakers **35** and **36** are provided on the cutting edges **22** and **24** respectively. As with the embodiment of Figure 1, the chip velocity vectors **10** are the same in all directions along the cutting edges **22** and **24**; i.e., the chip velocity vectors **10** are all designed to point essentially in the same parallel direction. In accordance with the second embodiment, however, chips will be broken up into smaller chips as they are created.

However, in spade bits of prior art, the chips have the tendency to flow in different directions, due to the fact that the chip velocity vectors are not aligned. Thus, the chip flow angles are not aligned either. As a result, additional energy is consumed to break up the chips into smaller pieces, or at least to deform them so that they can flow in one direction. The present invention spade bit aligns the velocity vectors in one single direction. Therefore, no energy is consumed to deform them or to break them apart. In addition, bigger chips are also easier to clear out of the hole.

However, with conventional drill bits and the first embodiment drill bit, the chips have the tendency to flow at different speeds. The cutting speed v is governed by the following equation: $v=2\pi fr$ where r is the radius at a point along the cutting edge, and f is the frequency of rotation (eg. 500 rotations per minute). Since the chip velocity is proportional to the cutting speed, it can be readily seen from the above equation that the speed at which a chip wants to flow is proportional to the radius r at any point along the cutting edge and therefore varies all along that edge. In other words, in conventional spade bits, energy is not only wasted tearing a chip apart due to different chip flow vectors

as described above, in addition energy is consumed attempting to deform the chip so as to break it up into smaller pieces so that each piece can flow at its own characteristic speed.

In other words, the above equation illustrates that the chip velocity would be different at each point along the cutting edge of a spade bit, as r varies and f is constant for the whole spade bit. Hence, in conventional drill bits and also in the first embodiment of the present design, energy is required to deform chips, so that they flow at a single velocity. The chipbreakers are designed to break chips into two or three smaller chips. This is an advantage over conventional designs since much less energy is wasted to deform the chips so that they can flow in one direction and at one uniform speed.

Breaking the chips into two to three pieces per side, means those two or three pieces can flow in one direction due to the aligned velocity vectors and nearly constant speed. Two or three chips per side is the preferred design to get the full benefit. Breaking the chips into more pieces would make it more difficult to clear them out of the hole.

The chip breakers **35** and **36** help to break up the chips into smaller pieces. In other words, a drill bit made in accordance with the second embodiment of the present invention requires no additional energy to be consumed in order to break up and deform the chips. The details of the chip breaker structure are best appreciated in connection with Figures 11-14. Figure 11 is an expanded edge view of a drill bit in accordance with the second embodiment of the invention having chip breaker points **35** and **36**. In the illustrated configuration, there is one chip breaker on each of the main cutting edges **22** and **24** although it will be appreciated by the artisan that the invention is not so limited. Also in the illustrated embodiment, each of the chip breakers are triangularly shaped and have as their included angle, an angle similar to the included angle of the point **16** of the spade bit. Although triangularly shaped chip breaker points are preferred, other shapes may also be used including non-pointed

i.e. rounded chip breakers and/or angles other than that of the point **16** may be used.

Figures 12 and 14 further illustrate the non-limiting structure of the chip breaker embodiment. In Figure 15, a detailed view of a spade having four chip breakers **35, 35'** and **36, 36'** is illustrated. In the embodiment of Figure 15, the length of the chip breaker i.e. the length it extends away from the cutting edges **22** and **24** is shown to be varied. This is illustrative of the fact that while the presently preferred chip breaker is a triangular shape at a certain length, combinations of different shapes (i.e., configurations) and different lengths or sizes are also within the scope of the present invention.

Figure 16-20 illustrate a third embodiment of the present invention. This embodiment encompasses essentially all of the structures and benefits of the first embodiment and additionally includes a threaded point structure. The threaded spade bit as illustrated in Figure 16A, 16B and 16C has the advantage of being self-feeding, i.e. it does not require the user to apply thrust force while drilling. Details of the threaded point **16** for a spade bit are best seen in Figures 17-19. The number of threads can vary depending upon the particular spade bit, but would typically vary in the range of between about 16 to 26 TIP. The lower number of threads the more aggressively the drill bit will feed itself into the material.

In the embodiment illustrated in Figure 17, there is depicted a 20 TIP thread ground using a plated grinding wheel **40** as shown in the dashed lines in Figure 17. In this embodiment, the threads are preferably ground using the wheel **40** adjusted at an angle slightly different from the angle **A** of the point **16**. In the non-limiting illustration of Figure 17, the point angle **A** is about 36°. Using the angle **A** of 36° as an example, the angle B, which is the included angle at which the threads are ground, would be in the range from about 32° to about 34°.

Figure 18B is an expanded view of a drill head having a threaded point **16** in accordance with the third embodiment. In Figure 18B, an exemplary configuration of a threaded point **16** formed in accordance with the invention is illustrated. Also see Figure 19 for an alternative perspective view of an exemplary configuration for the threaded portion **37** of the point **16**.

A spade bit having cutting edges designed in accordance with the first embodiment of the present invention bit with a conventionally threaded point **16** is illustrated in Figure 20. When using a drill having a conventionally threaded point design **38**, and assuming the operator is drilling in wood, should the bit hit a nail or another metal object, the thread is likely to become damaged. Slight damage to the threads **38** on the top end of the point **16** render the threads useless. Damaged threads do not function to self feed the drill bit. However, a self threading point designed according to the third embodiment of this invention overcomes the problem by providing threads which are ground to their full depth at the bottom of the point **16** and of gradually decreasing depth towards the top of the point. In other words, in Figure 18B, the depth of the thread **37'** is less than the depth of the thread **37''**. This is accomplished by adjusting the grinding wheel angle as described above in connection with angles C and D, thus leaving more material on the top or tip end of the point **16** so that it can withstand the impact for example of hitting a nail or any other kind of metal type material possibly embedded in the wood. In contradistinction, in the conventional tip design of Figure 20, the angles **C** and **D** are typically identical, which gives rise to the disadvantages noted above.

The foregoing description of preferred embodiments of the invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed and obviously many modifications and variations are possible in light of the above teaching. For example, the size, number

and placement of the chip breaker members may vary as may the particular configuration of the threaded point design. The basic design consideration of the first embodiment of the invention is to ensure that the chip flow direction all along the cutting edge of the drill is always in the same direction. As long as the cutting blade is designed so that the chip velocity vectors are always generally perpendicular to a line drawn from each point on the main cutting edge relative to the center access to the spade bit, the advantages of the invention can be realized. The embodiments illustrated were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto:

Claims

1. A spade bit comprising:

a) a shank; and

b) a cutting head, the cutting head comprising:

i) a point;

ii) a pair of cutting edges extending generally radially outward from said point, said cutting edges creating velocity vectors of cuttings which are generally parallel to each other along essentially the entire cutting edge.

2. The spade bit according to claim 1 wherein said cutting edges have rounded outer edges.

3. The spade bit according to claim 1 wherein said cutting edges are essentially free of edge spurs.

4. The spade bit according to claim 1 wherein said cutting edges are provided with chip breakers.

5. The spade bit according to claim 4 wherein said chip breakers are generally triangular in shape.

6. The spade bit according to claim 4 wherein said each cutting blade has one chip breaker formed thereon.

7. The spade bit according to claim 4 wherein each cutting blade has two chip breakers formed thereon.

8. The spade bit according to claim 7 wherein each of said at least two chip breakers is of essentially the same size.

9. The spade bit according to claim 7 wherein each of said at least two chip breakers is of the configuration.

10. The spade bit according to claim 7 wherein said chip breakers are of different size.

11. The spade bit according to claim 7 where said chip breakers are of different configuration.

12. The spade bit according to claim 1 wherein said point has a tip and a base and threaded edges, the threads being formed at an angle with respect to the contour of said edges whereby the thread depth at the tip of the point is shallower than the thread depth at the base of the point.

13. The spade bit according to claim 4 wherein said point has a tip and a base and threaded edges, the threads being formed at an angle with respect to the contour of said edges whereby the thread depth at the tip of the point is shallower than the thread depth at the base of the point.

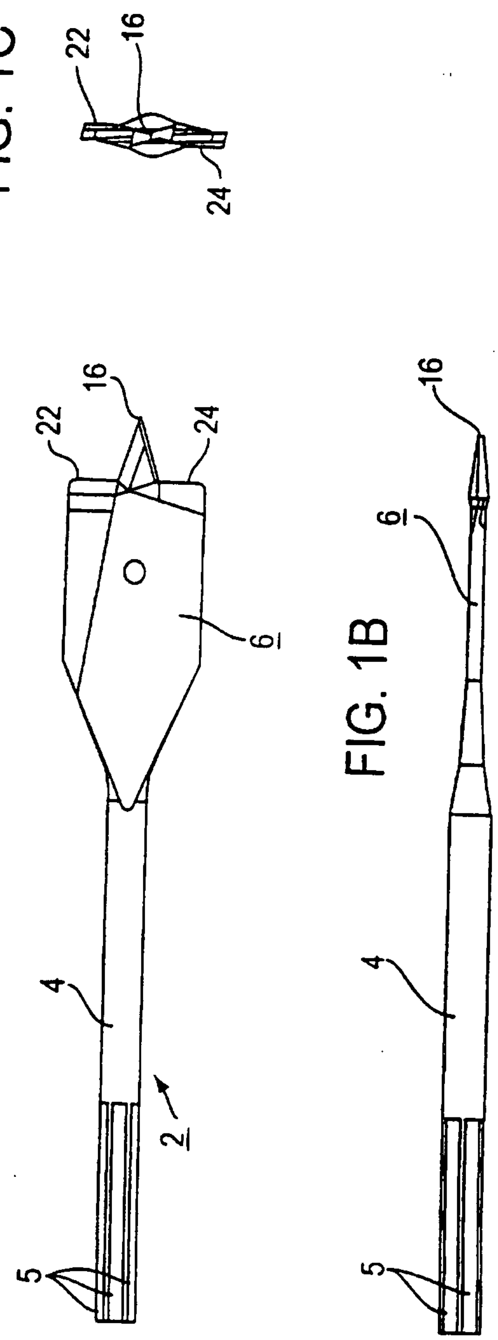


FIG. 1A

FIG. 1B

FIG. 1C

FIG. 2C

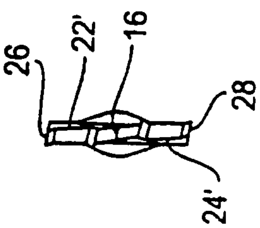


FIG. 2A

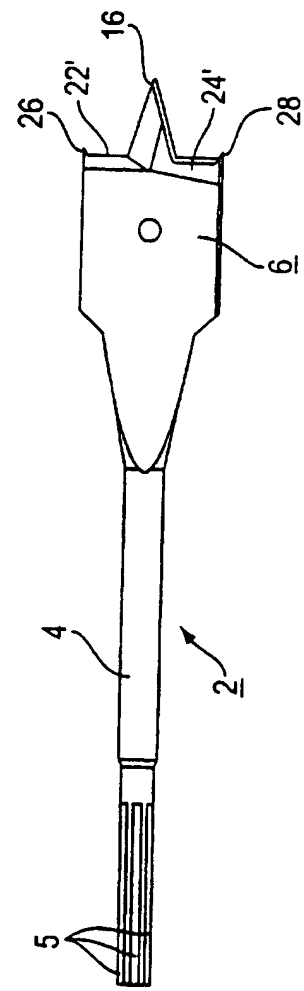


FIG. 2B

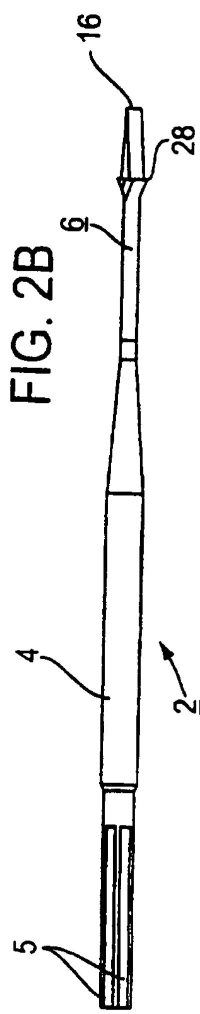


FIG. 3A

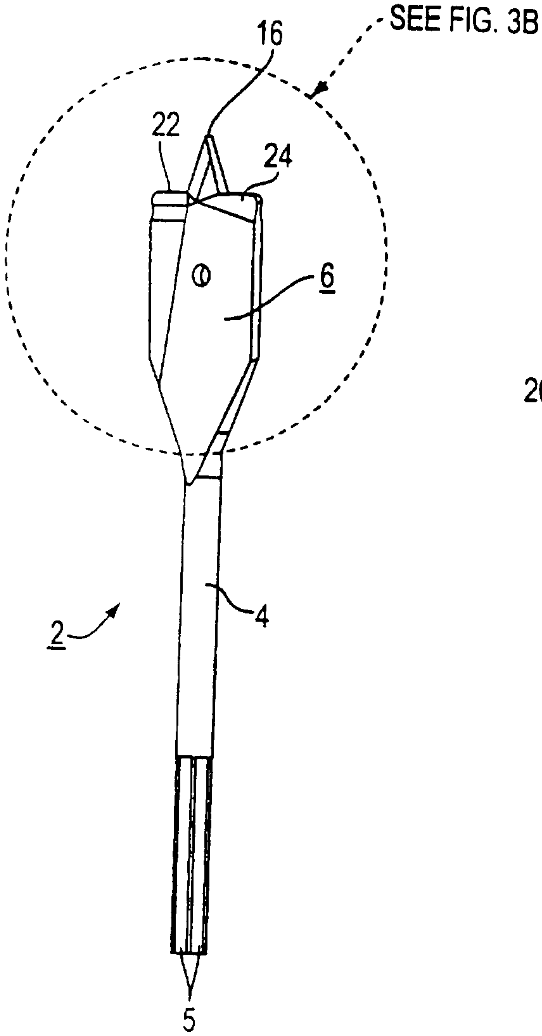


FIG. 3B

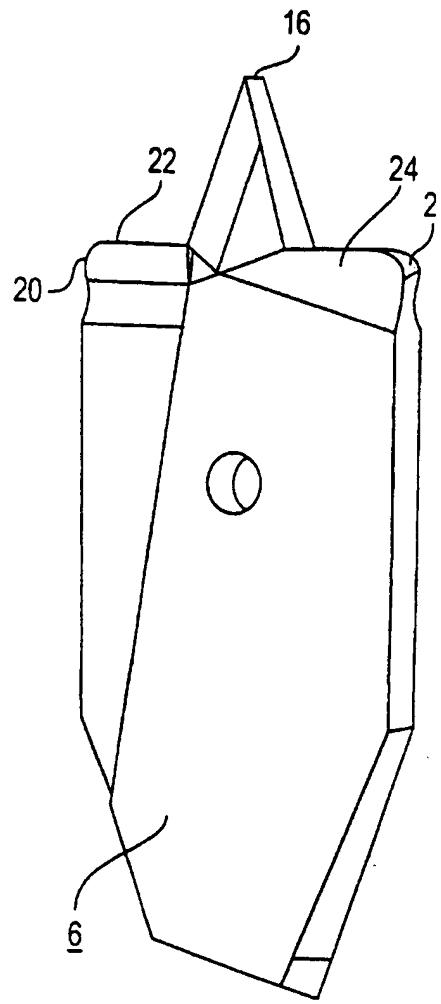


FIG. 4A

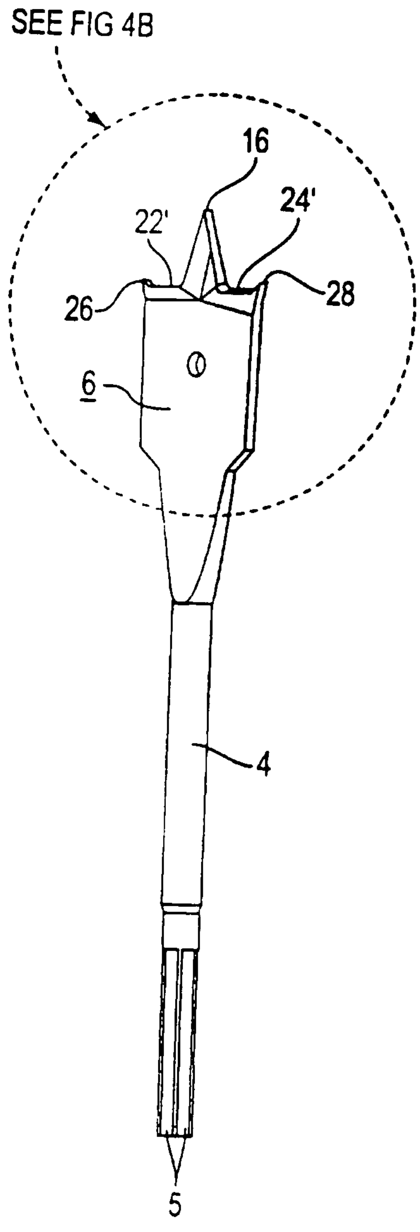


FIG. 4B

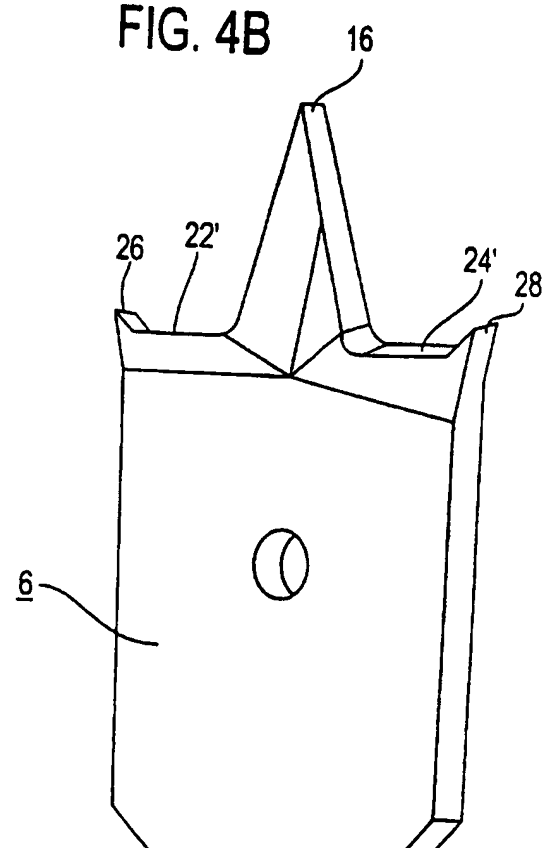


FIG. 5

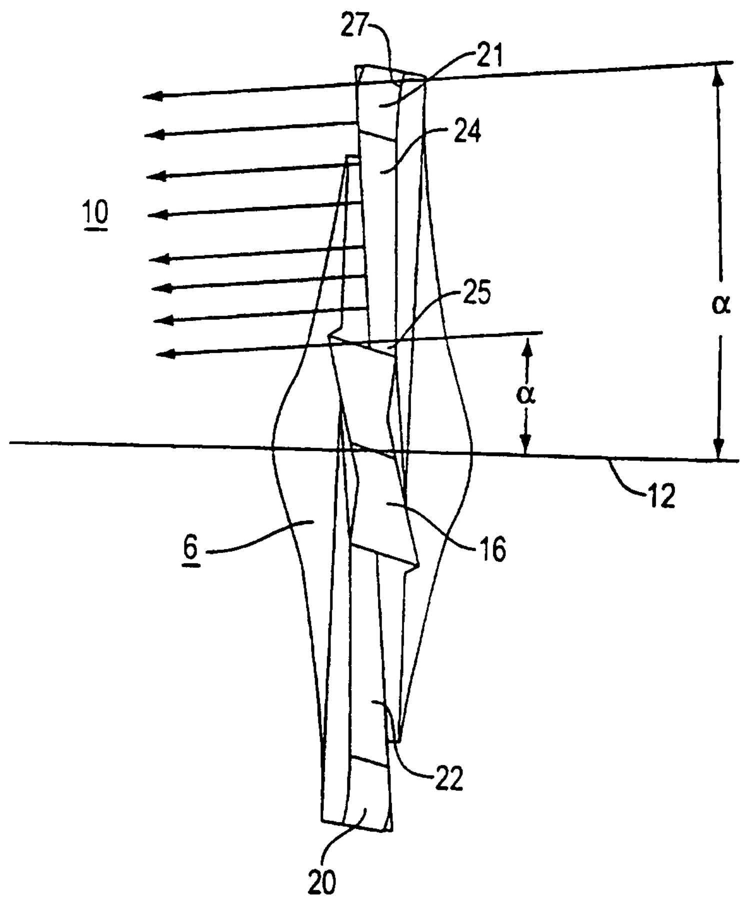


FIG. 6

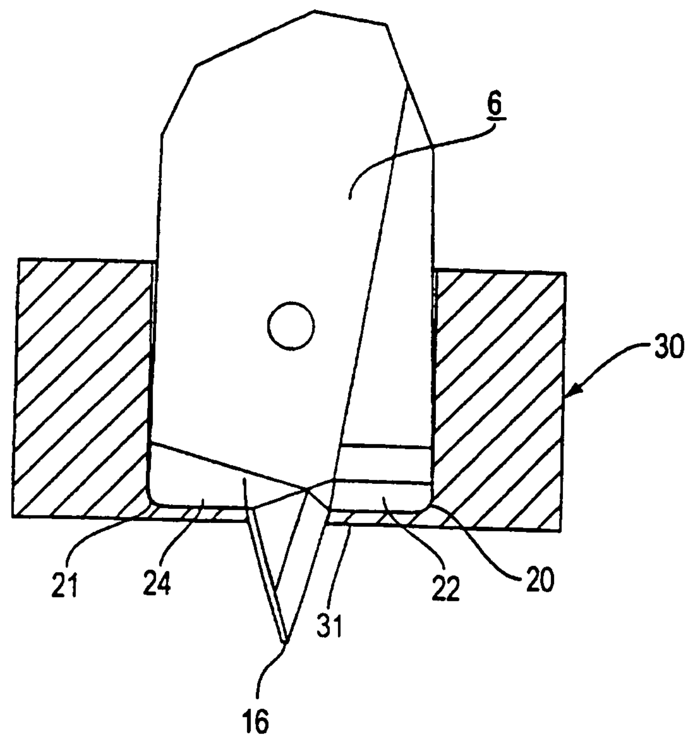


FIG. 7

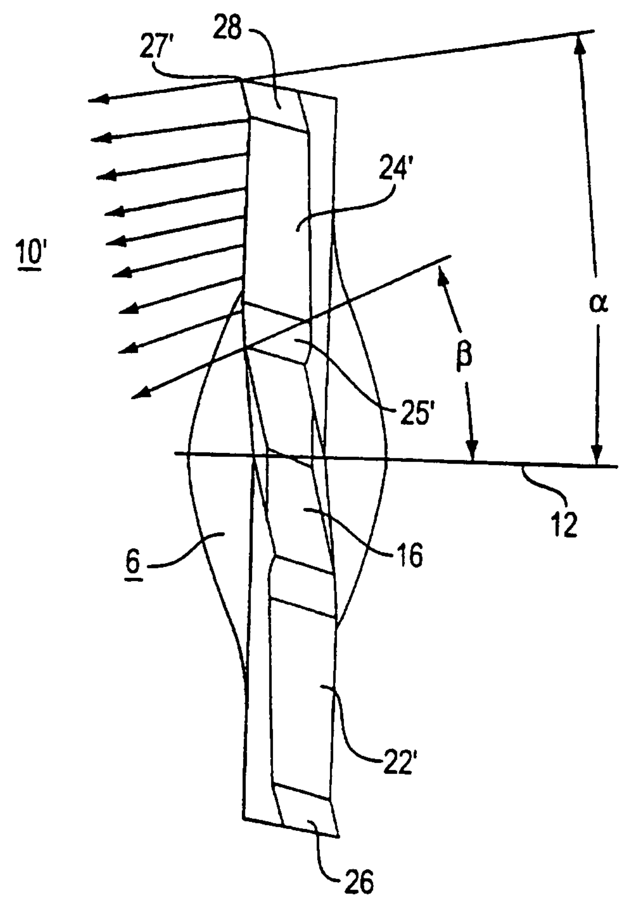


FIG. 8

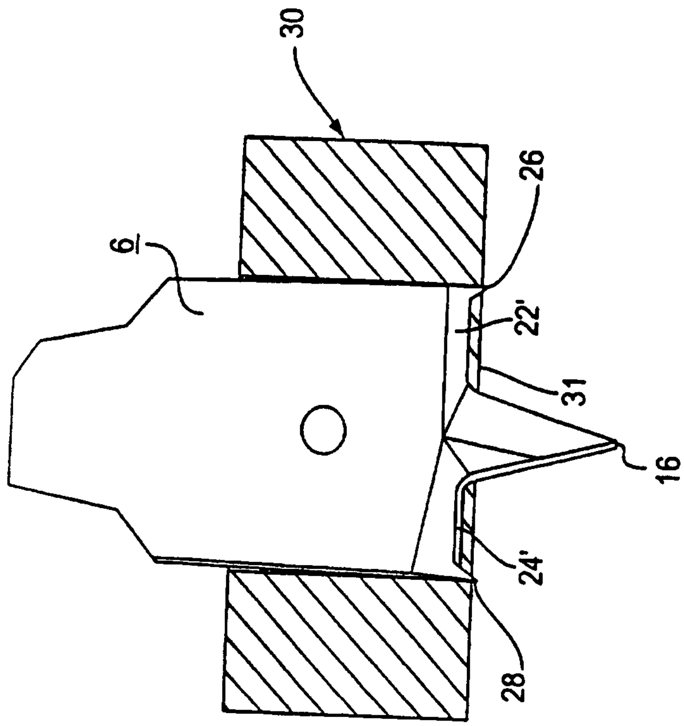
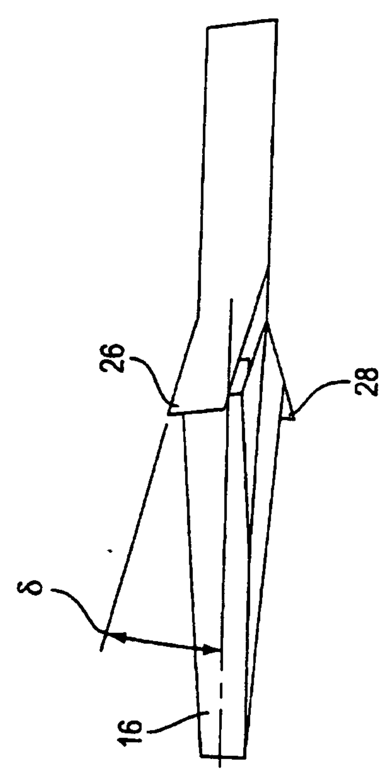


FIG. 9



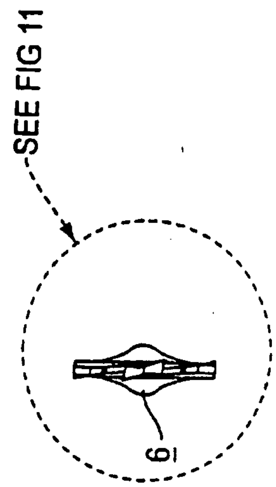


FIG. 10C

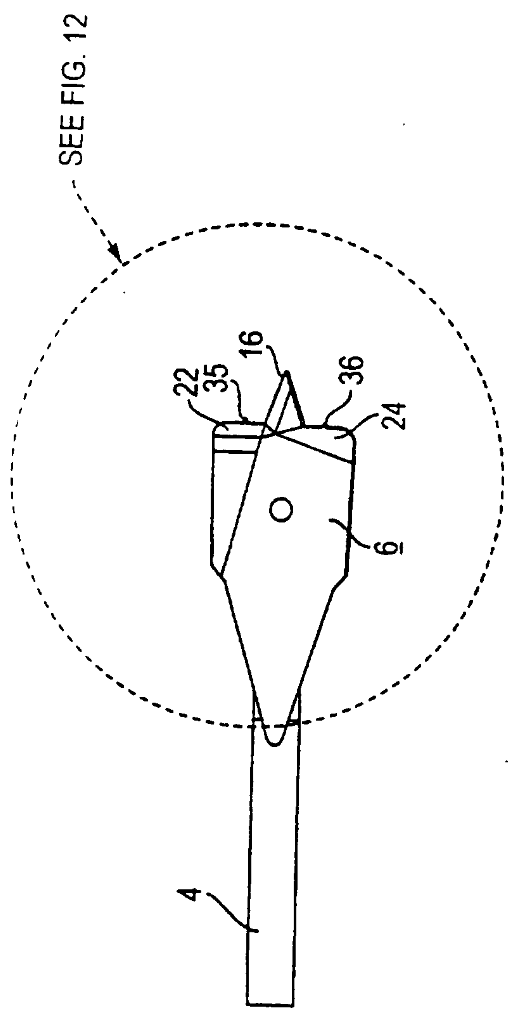


FIG. 10A

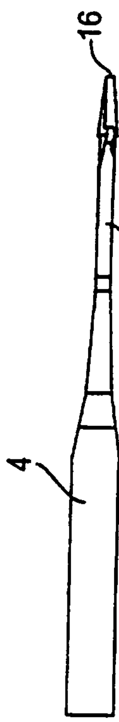


FIG. 10B

FIG. 11

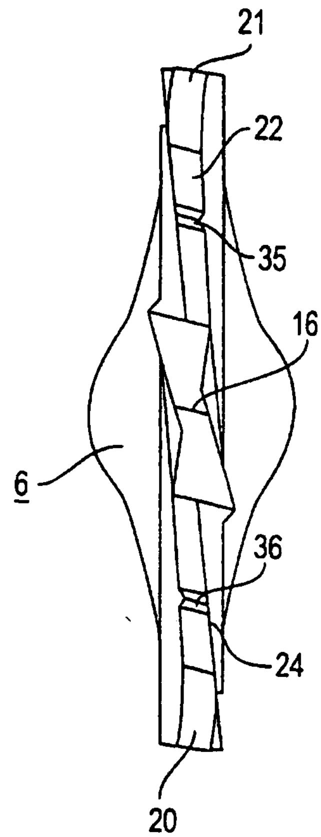


FIG. 12

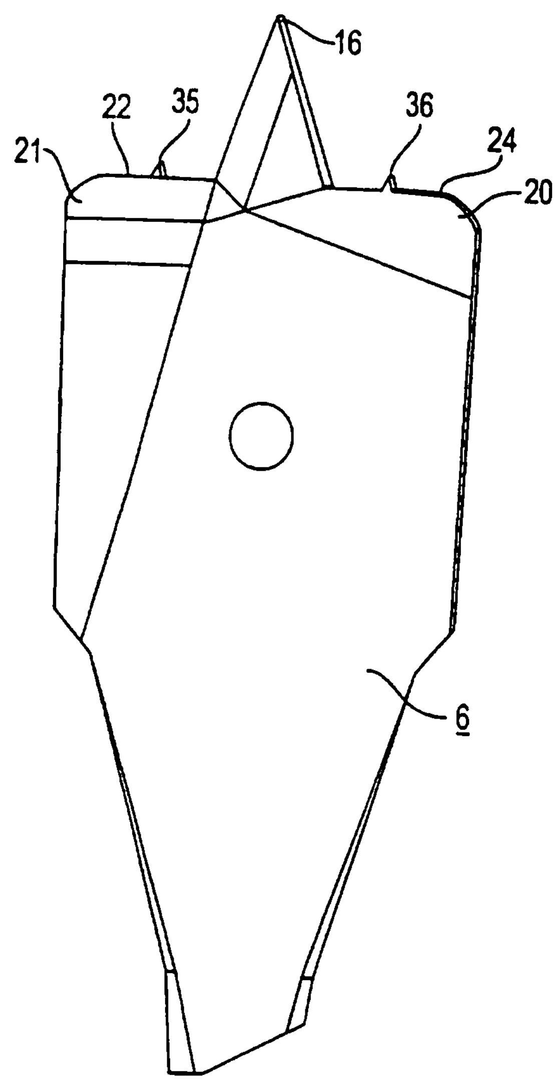


FIG. 13

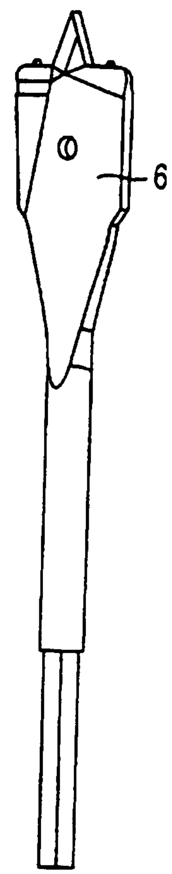


FIG. 14

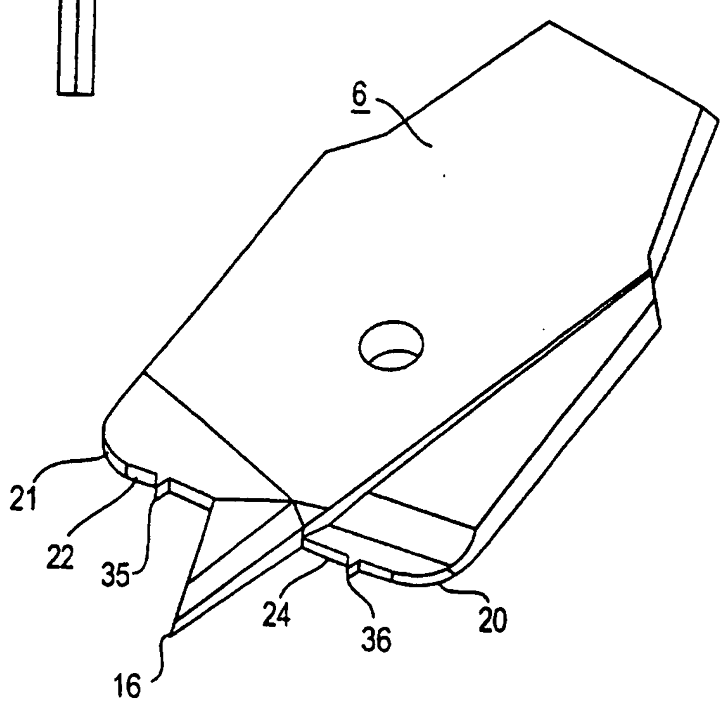
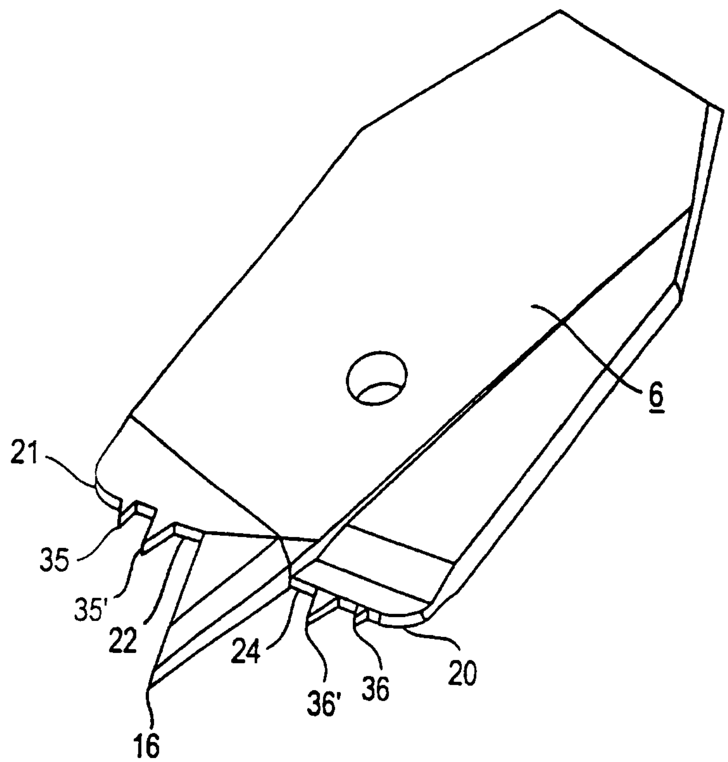


FIG. 15



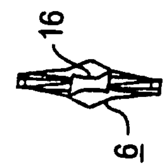


FIG. 16C

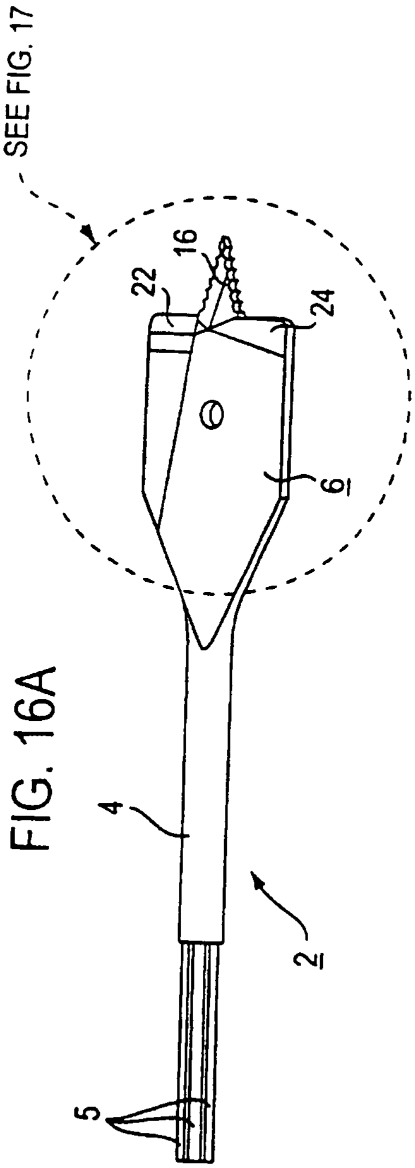


FIG. 16A

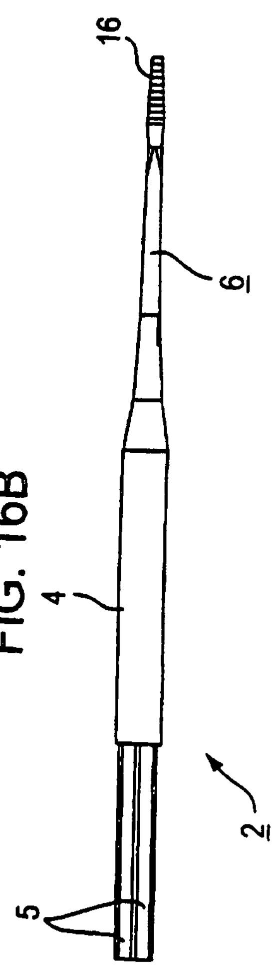


FIG. 16B

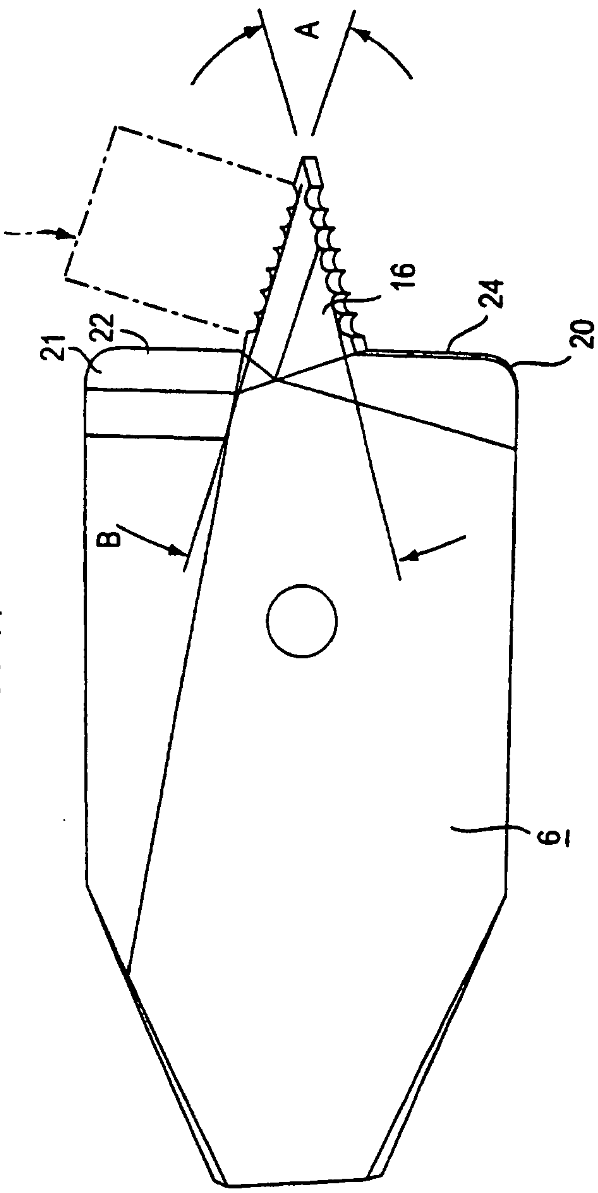


FIG. 17

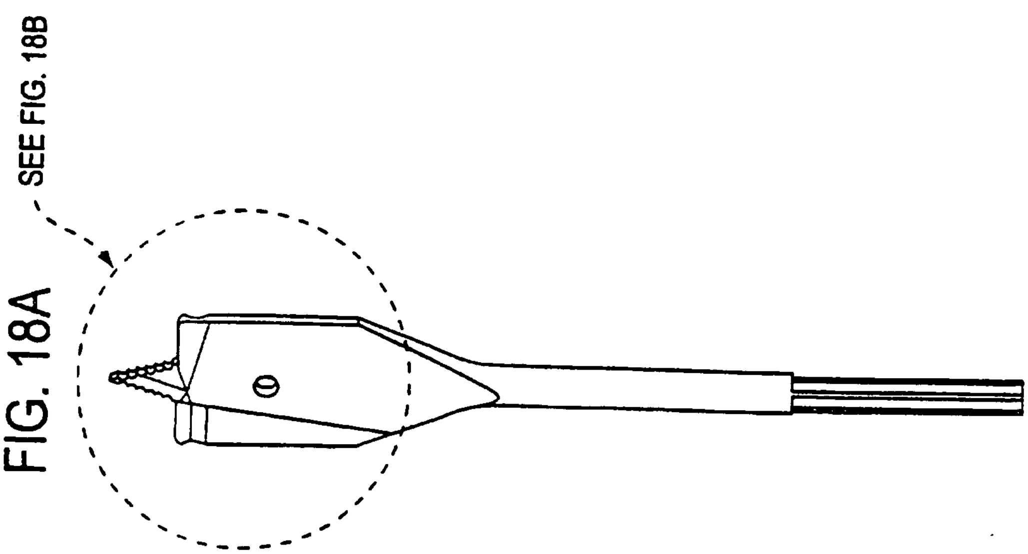


FIG. 18A

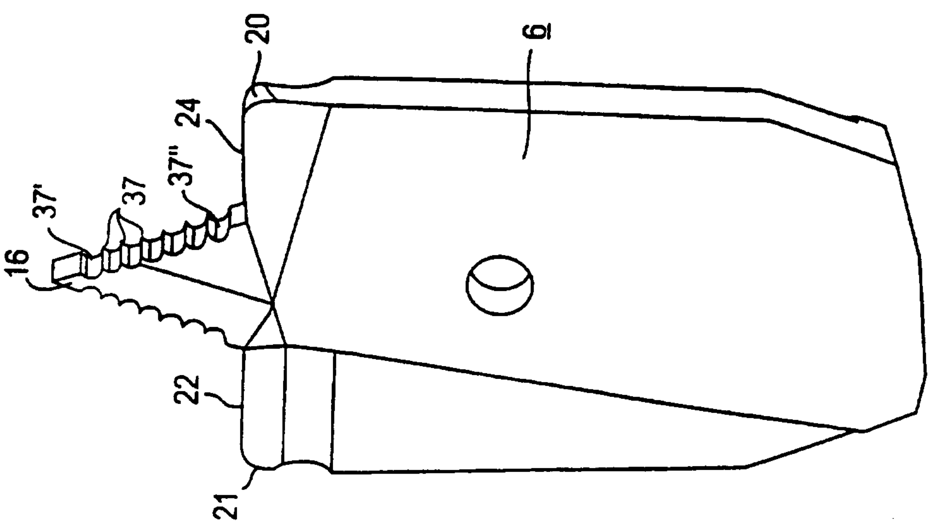
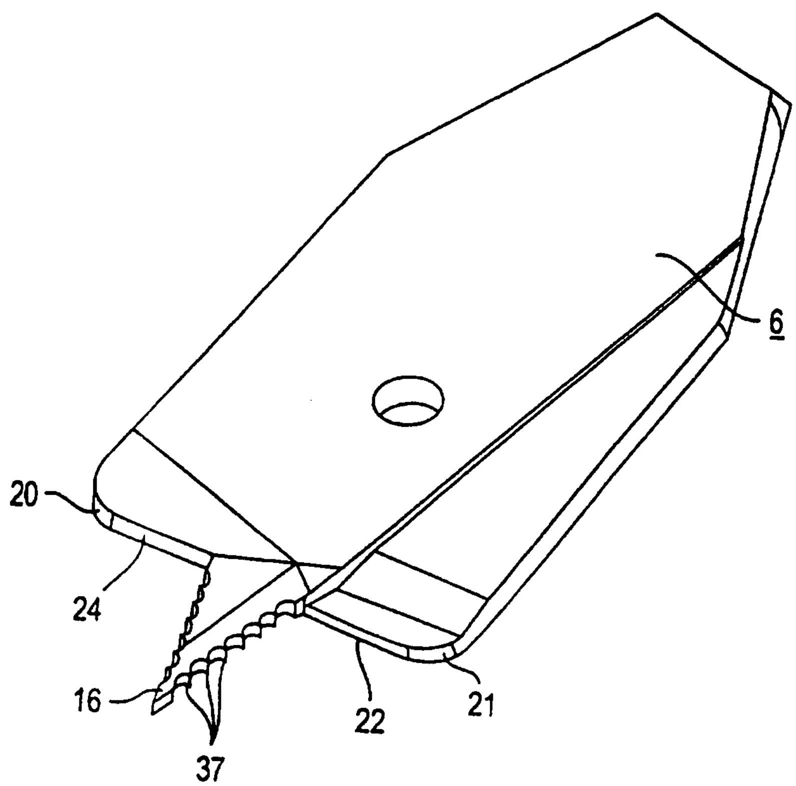


FIG. 18B

FIG. 19



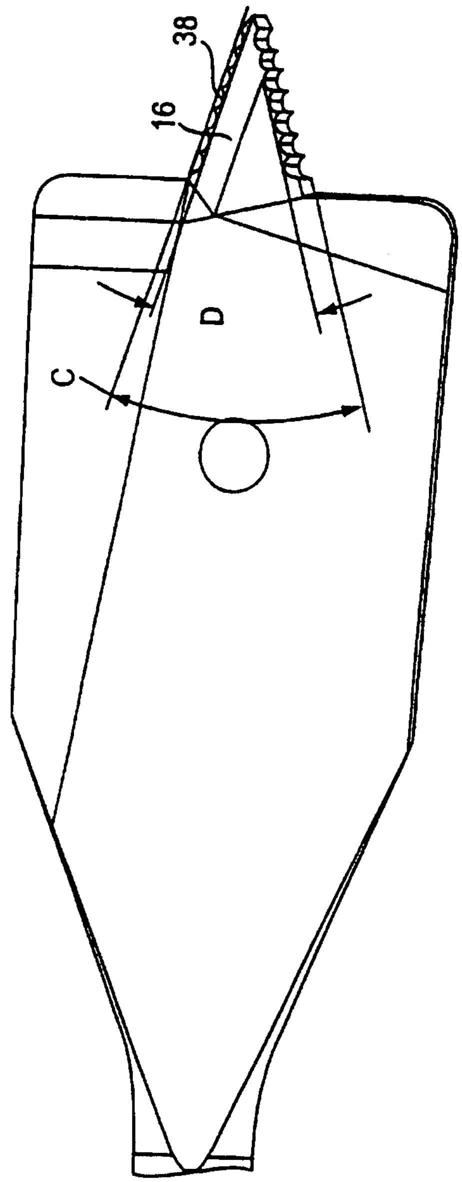


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/13766

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B23B 51/00
US CL :408/214, 225, 228
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 408/211, 214, 223, 224, 225, 227, 228

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 2,543,206 A (SMITH) 27 February 1951, see figures 1-5 and column 2, line 54 to column 3, line 2	1, 3 ---- 2, 4-11
X	US 3,920,350 A (SOUTHALL, DECEASED) 18 November 1975, see figures 1-4	1, 3
X ---- Y	US 4,286,904 A (PORTER ET AL) 01 September 1981, see figures 1-3	1, 3 ---- 2, 4-11
X ---- Y	GB 2,130,935 A (DALEY) 13 June 1984, see figures 6-8	1, 3, 12 ---- 13
Y	US 5,273,380 A (MUSACCHIA) see figure 6	2

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 NOVEMBER 1997	17 NOV 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer for DANIEL W. HOWELL Sheila Veney Paralegal Specialist Group 3200 Telephone No. (703) 308-1148

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/13766

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 2,421,022 A (TANGUY) 26 October 1979, see figure 1	4-6
Y	SU 1,151,374 A (TOOL RESEARCH INSTITUTE) 23 April 1985, see figures 1-2	4, 5, 7-11

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